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METHODS AND SYSTEMS FOR THE EVALUATION OF POWER GENERATING FACILITIES

BACKGROUND OF THE INVENTION

[0002] This invention relates generally to a decision making process and, more particularly, to network-based systems and methods for the evaluation of power generating facilities.

[0003] The financial management function of a business entity is responsible for evaluating acquisition candidates, sometimes referred to as power plants or power generating facilities and to monitor the performance of existing assets. The task of evaluation requires performing detailed technical and financial analyses and using the results as the basis of making recommendations to management to acquire power generating facilities that are profitable or to report on the financial condition of a specific asset. In today's environment, the financial management function expends substantial resources in inspecting the power plants, collecting business and operational data, collecting maintenance and fuel costs, analyzing data, and making recommendations to the business entity based on short term and long term operating objectives. The analysis, in part, is based on various operating models, which in turn are driven by assumptions. Setting assumptions, identifying methodology and formulas to compute the financial metrics, and establishing consistency and reliability in every power plant evaluation could be a significant task. These tasks are also very time-consuming and are often done manually without any fixed methodology. Such tasks, therefore, take away resources of the corporation from its operations and other profitable activities.

[0004] Therefore, it would be desirable to implement systems and processes that evaluate and make recommendations regarding existing and potential power generating assets using pre-defined criteria. It would be further desirable to

utilize automated databases which are web-based enabled as input into the system so that consistent up-to-date information is used in the evaluation process.

BRIEF SUMMARY OF THE INVENTION

[0005] In an exemplary embodiment, a Power Plant Revenue Prediction System (PPRPS) allows users to evaluate the operational and financial performance of a selected power generating asset by utilizing a pre-defined strategic model. The system allows both experienced and novice users to complete a detailed analysis of various power plants and to evaluate their long term financial viability. . The system assists the user to perform comparisons of various facilities and make sound management decisions. The system further helps reduce costs by streamlining the internal analysis process and providing consistency in decision making process.

[0006] More specifically, the invention is a dynamic system which utilizes web and intranet-based databases along with internal databases to analyze and evaluate power generating assets utilizing a strategic decision model. The system includes a client system, a data storage device, and a server system. The system receives facility information, allocates operating expenses based on prior experience in evaluating the facility, calculates facility cost and associated return on investment, and provides various management reports that provide operational details and recommendations to management for a selected power generating asset . The system captures all facility information and provides on-line, up-to-date information upon a user request. In one exemplary embodiment, the system utilizes a Structured Query Language (SQL) server database with a client user interface front-end for administration and a web interface for standard user inputs and reports. The system includes a centralized database for use in automating documentation, monitoring and records retention activities associated with the power generating operating expenses allocation, and making strategic decisions.

[0007] In one embodiment, a method for making management recommendations on a selection or performance of a power plant asset , uses a network-based system. The method includes identifying assumptions to evaluate the power generating asset , receiving power plant facility information, and computing performance metrics of the facility based on received information and identified assumptions.

[0008] In another embodiment of the invention, a computer program is embodied on a computer readable medium for managing evaluation and selection of a power plant. The computer program includes a code segment that receives facility information and then maintains a database by adding, deleting and updating information, generates management reports based on facility information, and provides flexibility to an administrator to modify user profile information. The program further provides online help to the user by downloading a user manual on to a client device. In a specific embodiment, the computer program is capable of generating Operations Cost Summary Report, a General Information Report, a Capital Costs Summary Report, an Annual Maintenance Costs Report, a Major Maintenance Summary Report, a Fees and Services Report, a Direct Material Report, an Equipment, Rental & Spares Report, a Fuels Report, a Coal Offset Report, an O & M Labor Report, Purchased Power & Fuel Calculations Report, a Steam Correction Factor Report, a Turbine Generator Report, a Dispatch Information Report, an Annual Summary of Key Information to Analyze Potential Investment Report, a CO2 Tax Calculations Report, and an Operational Cost Summary Report.

[0009] In yet another embodiment of the invention, a database includes data corresponding to Boiler Data, Feed Water Data, Balance of Plant Data, Turbine Data, and APC Equipment Data. Various data within the database is cross referenced against unique identifiers for easy retrieval and storage. The database further includes data corresponding to key assumptions and mathematical algorithms and is secured from access by unauthorized individuals.

[0010] Other embodiments of the invention utilize an Apparatus or a Computer for determining a value for one or more power generating facilities based on pre-determined assumptions that are developed from historical experience.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Figure 1 is a block diagram of a Power Plant Revenue Prediction System (PPRPS).

[0012] Figure 2 is an expanded version of a block diagram of an exemplary embodiment of a server architecture of a PPRPS 22.

[0013] Figure 3 shows a configuration of the database within the database server of the server system shown in Figure 1.

[0014] Figure 4 through 8 are exemplary embodiment of user interfaces through which the user inputs power plant related information and provides the Percentage of Available Hours Dispatched as well as the Dispatched Load input for each Unit.

[0015] Figure 9 is an exemplary embodiment of a user interface.

[0016] Figure 10 is an exemplary embodiment of a user interface.

[0017] Figure 11 is an exemplary embodiment of a user report that calculates the predicted performance of each unit based on the information from the input worksheets identified in Figures 4 through 10.

[0018] Figures 12 and 13 are exemplary embodiment of user report summarizing the fixed and variable costs for each unit based on the assumptions included in the input interfaces in Figures 4 through 10.

[0019] Figures 14 through 17 are exemplary embodiments of user reports providing overview and verification of input and design assumptions.

[0020] Figure 18 is an exemplary embodiment of a user report that provides the cost estimates of a new unit(s) based on the inputted information into system.

[0021] Figure 19 is an exemplary embodiment of a user report displaying annual summary of maintenance expenses of all units at a given time for a selected facility.

[0022] Figure 20 is an exemplary embodiment of a user report displaying annual Operator's Fees and Services.

[0023] Figure 21 is an exemplary embodiment of a Direct Material Cost Summary Report displaying direct material related information.

[0024] Figure 22 is an exemplary embodiment of an Equipment Rentals/ Lease and Spares Report displaying the cost associated with Rentals, Lease and Planned Spares information.

[0025] Figures 23 and 24 are an exemplary embodiment of a Fuel Report providing fuel characteristics to verify that appropriate equipment has been installed.

[0026] Figure 25 is an exemplary embodiment of a Coal Offsets Report.

[0027] Figures 26 and 27 are an exemplary embodiment of an O & M Labor, Purchased Power and Start-up Fuel Calculations Report providing a staffing summary which identifies the number of employees per position along with annual labor costs .

[0028] Figures 28 and 29 are an exemplary embodiment of a Turbine Generation Report.

[0029] Figure 30 is an exemplary embodiment of a Dispatch Information Report.

[0030] Figure 31 is an exemplary embodiment of an Operations Report providing an annual summary of key information used in analyzing a potential investment.

[0031] Figure 32 is an exemplary embodiment of a Carbon Tax Costs Report.

[0032] Figure 33 is a flow chart depicting the steps utilized by the PPRPS..

DETAILED DESCRIPTION OF THE INVENTION

[0033] Exemplary embodiments of systems and processes that facilitate integrated network-based electronic reporting and workflow process management related to a Power Plant Revenue Prediction System (PPRPS) are described below in detail. The systems and processes facilitate, for example, electronic submission of information using a client system, automated extraction of information, and web-based assessment reporting and management.

[0034] The systems and processes are not limited to the specific embodiments described herein. In addition, components of each system and each process can be practiced independent and separate from other components and

processes described herein. Each component and process also can be used in combination with other components and processes.

[0035] In an exemplary embodiment, the application is implemented as a Centralized Database utilizing a Structured Query Language (SQL) with a client user interface front-end for administration and a web interface for standard user input and reports. The application is web enabled and runs on a business entity's intranet. In a further exemplary embodiment, the application is fully accessed by individuals having authorized access outside the firewall of the business entity through the Internet. In another exemplary embodiment, the application is run in a Windows NT environment or simply on a stand alone computer system. In yet another exemplary embodiment, the application is practiced by simply utilizing spreadsheet software or even through manual process steps. The application is flexible and designed to run in various different environments without compromising any major functionality.

[0036] Figure 1 is a block diagram of PPRPS 10 that includes a server sub-system 12, sometimes referred to herein as server 12, and a plurality of customer devices 14 connected to server 12. Computerized modeling and grouping tools, as described below in more detail, are stored in server 12 and can be accessed by a requester at any one of computers 14. In one embodiment, devices 14 are computers including a web browser, and server 12 is accessible to devices 14 via a network such as an intranet or a wide area network such as the Internet. In an alternative embodiment, devices 14 are servers for a network of customer devices. Customer device 14 could also be any client system capable of interconnecting to the Internet including a web based digital assistant, a web-based phone or other web-based connectable equipment. In another embodiment, server 12 is configured to accept information over a telephone, for example, at least one of a voice responsive system where a user enters spoken data, or by a menu system where a user enters a data request using the touch keys of a telephone as prompted by server 12.

[0037] Devices 14 are interconnected to the network, such as a local area network (LAN) or a wide area network (WAN), through many interfaces including dial-in-connections, cable modems and high-speed lines. Alternatively, devices 14 are any device capable of interconnecting to a network including a web-based phone or other web-based connectable equipment. Server 12 includes a database server 16 connected to a centralized database 20. In one embodiment, centralized database 20 is stored on database server 16 and is accessed by potential

customers at one of customer devices 14 by logging onto server sub-system 12 through one of customer devices 14. In an alternative embodiment, centralized database 20 is stored remotely from server 12.

[0038] Figure 2 is an expanded version block diagram of an exemplary embodiment of a server architecture of a PPRPS 22. PPRPS 22 is implemented for the complex environment. Components in PPRPS 22, identical to components of system 10 (shown in Figure 1), are identified in Figure 2 using the same reference numerals used in Figure 1. PPRPS 22 includes server sub-system 12 and customer devices 14. Server sub-system 12 includes database server 16, an application server 24, a web server 26, a fax server 28, a directory server 30, and a mail server 32. A disk storage unit 34 is coupled to database server 16 and directory server 30. Servers 16, 24, 26, 28, 30, and 32 are coupled in a local area network (LAN) 36. In addition, a system administrator work station 38, a work station 40, and a supervisor work station 42 are coupled to LAN 36. Alternatively, work stations 38, 40, and 42 are coupled to LAN 36 via an Internet link or are connected through an intranet.

[0039] Each work station 38, 40, and 42 is a personal computer including a web browser. Although the functions performed at the work stations typically are illustrated as being performed at respective work stations 38, 40, and 42, such functions can be performed at one of many personal computers coupled to LAN 36. Work stations 38, 40, and 42 are illustrated as being associated with separate functions only to facilitate an understanding of the different types of functions that can be performed by individuals having access to LAN 36.

[0040] Server sub-system 12 is configured to be communicatively coupled to various individuals or employees 44 and to third parties, e.g., a customer 46 via an ISP Internet connection 48. The communication in the exemplary embodiment is illustrated as being performed via the Internet, however, any other wide area network (WAN) type communication can be utilized in other embodiments, i.e., the systems and processes are not limited to being practiced via the Internet. In addition, and rather than a WAN 50, local area network 36 could be used in place of WAN 50.

[0041] In the exemplary embodiment, any employee 44 or customer 46 having a work station 52 can access server sub-system 12. One of customer devices 14 includes a work station 54 located at a remote location. Work stations 52

and 54 are personal computers including a web browser. Also, work stations 52 and 54 are configured to communicate with server sub-system 12. Furthermore, fax server 28 communicates with employees 44 and customers 46 located outside the business entity and any of the remotely located customer systems, including a customer system 56 via a telephone link. Fax server 28 is configured to communicate with other work stations 38, 40, and 42 as well.

[0042] The systems described in Figures 1 and 2 are configured to implement a methodology to determine revenues likely to be generated by one or more power plants, based upon actual historical operations and cost data and predicted operations and cost data. By determining a likely revenue stream, a value can be placed on the power plants for potential purchasers, and for those who are desiring to borrow against equity in the power plants.

[0043] Figure 3 shows a configuration of database 20 within database server 16 of server system 12 shown in Figure 1. Database 20 is coupled to several separate components within server system 12. These separate components perform specific tasks as required to achieve the system functionality.

[0044] Server system 12 includes a collection component 64 for collecting information from users into centralized database 20, a tracking component 66 for tracking information, a displaying component 68 to display information, a receiving component 70 to receive a specific query from client system 14, and an accessing component 72 to access centralized database 20. Receiving component 70 is programmed for receiving a specific query from one of a plurality of users. Server system 12 further includes a processing component 76 for searching and processing received queries against data storage device 34 containing a variety of information collected by collection component 64. An information fulfillment component 78, located in server system 12, downloads the requested information to the plurality of users in the order in which the requests were received by receiving component 70. Information fulfillment component 78 downloads the information after the information is retrieved from data storage device 34 by a retrieving component 80. Retrieving component 80 retrieves, downloads and sends information to client system 14 based on a query received from client system 14 regarding various alternatives.

[0045] Retrieving component 80 further includes a display component 84 configured to download information to be displayed on a client system's graphical user interface and a printing component 88 configured to print

information. Retrieving component 80 generates various reports requested by the user through client system 14 in a pre-determined format. System 10 is flexible to provide alternative reports and is not constrained to the options set forth above.

[0046] In an exemplary embodiment, database 20 is divided into a Boiler Data Section (BDS) 90, a Feed Water Data Section (FWDS) 92, a Balance of Plant Section (BOPS) 94, a Turbine Data Section (TDS) 96, and an APC Equipment Section (AES) 98. Sections 90, 92, 94, 96 and 98 within database 20 are interconnected to update and retrieve the information as required. Each Section is further divided into several individualized sub-sections to store data in various different categories. In yet another exemplary embodiment, customized sections are developed using key evaluation metrics.

[0047] The architecture of system 10 as well as various components of system 10 are exemplary only. Other architectures are possible and can be utilized in connection with practicing the processes described below.

[0048] Figures 4 through 10 are exemplary embodiments of user interfaces utilized in inputting power plant related information for up to eight units at one site location. Specific information required includes unit gross capacity, number of hours that the unit has operated since the Commercial Operation (CO) date, the number of hours that the unit will be available for operation, and the anticipated load that the unit will be dispatched. Through a user interface 120 shown in Figure 4, the user inputs a Unit Gross Output 122 and a House Load 124. Unit Gross Output 122 is the full load Maximum Continuous Rating (MCR) of each Unit. House Load 124 is the percentage of the units' gross output 122 that will be internally consumed in operating internal components. An option is provided to the user to select a typical value stored in database 20, which is automatically adjusted for the type of equipment 126, a Flyash Control Equipment, a SO_2 Control Equipment, a Mercury Control Equipment, or a NO Control Equipment (Shown in Figure 10 below), that is selected, or the actual values. The user also inputs Existing Operational Hours 128, Percentage of Available Hours Dispatched 130 and Dispatched Load 132. Existing Operational Hours 128 are the actual hours of operation since the installation of the unit. Percentage of Available Hours Dispatched 130 is the percentage of hours that the units will be available for dispatch. Dispatched Load 132 is the anticipated average load at which the units will be operating when dispatched.

[0049] Figures 5 through 8 are exemplary embodiments of user interfaces utilized in inputting power plant related information when there is more than one unit at a given site location.

[0050] Figure 9 is an exemplary embodiment of a user interface 140. User interface 140 allows the user to input Fuels Information 142, Cycle 144, Feed Water Temperature 146, and Stack Temperature 148. Fuels Information 142 input allows the user to select standard fuel analyses of coal, oil or natural gas or to input actual values for a given unit. The actual input information fields disappear if the user selects standard analyses as one of the options. Cycle 144 allows the user to select standard unit cycles or to input actual values. The actual input information fields disappear if standard cycles are selected. Feed Water Temperature 146 allows the user to select a standard feed water temperatures or input actual values. The actual input information fields disappear if standard temperatures are selected. Stack Temperature 148 allows the user to select standard stack temperatures or to input actual values. The actual input information fields disappear if standard temperatures are selected.

[0051] Figure 10 is an exemplary embodiment of a user interface 160. User interface 160 prompts the user to input the type of Air Pollution Control Equipment installed on each Unit. If the user selects a Flyash Control Equipment 162, a SO_2 Control Equipment 164, a Mercury Control Equipment 166, or a NO Control Equipment 168, Standard types of equipment are provided. In each case, the initial capital cost, maintenance costs, labor costs, cost of consumables, internal power consumption, and equipment performance are factored into the economic performance of the units and stored into database 20 for future access and retrieval.

[0052] The user is further allowed to input Coal Pricing information 170 by inputting the actual cost of the coal, oil or natural gas as well as the transportation costs associated with the same. System 10 is flexible to accommodate additional inputs for other consumables such as startup fuel and limestone.

[0053] Figure 11 is an exemplary embodiment of a user interface 190 that calculates the predicted performance of each unit based on the information from the input worksheets identified in Figures 4 through 10. User interface 190 provides information on the operational and performance details and calculates fuel consumption and unit heat rates including Gross Heat Rate per Hour 192 and Net Heat Rate per Hour 194, at various load conditions. In an exemplary embodiment (not

shown), various load conditions utilized in computations range from 25 to 99 % with an increment of one percentage load condition. User interface 190 also computes Heat Losses 196, Efficiency of the Unit 198, Gross Heat Fired 200 in million BTU per hour, Super Heater Flow 202, Re-Heater Flow 204, Heat Input 206, Equivalent Output 208, Reheat To Superheat Ratio 210 and various other operational parameters. User interface 190 information is used as inputs for other worksheets to predict fuel and other consumable consumption. The information contained in user interface 190 is also used to verify the actual performance of the units at a specific load condition. User interface 190 further calculates the approximate dimensions of the boilers' furnace for operational considerations.

[0054] Exemplary embodiment of a user interface 220 and a user interface 230, displayed in Figures 12 and 13 respectively, summarize the fixed and variable costs for each unit based on the assumptions included in the input interfaces in Figures 4 through 10. Output from user interface 220 and user interface 230 is used as input to other financial models. In another exemplary embodiment, output from user interfaces is directly downloaded into other financial models. In an exemplary embodiment, system 10 downloads and displays Fixed Costs, Variable Costs, Maintenance Costs, Fuel Costs and other associated underlying details. System 10 provides an overview of a Total Operating Budget that is required to generate specific power.

[0055] Figures 14 through 17 are exemplary embodiments of user interfaces providing overview and verification of input and design assumptions. The user has an option to modify input or alter assumptions to evaluate alternative options. Figures 14 through 17 summarize Facility Generation Information 240, Operational Information 242, Qualified Facility (QF) Steam Information 244, Operator Related Information 248, Facility Equipment Information 250, Fuels Information 254, Furnace Volume Design Parameters 258 and other related information.

[0056] Figure 18 is an exemplary embodiment of a user interface 270 that provides the cost estimates of a new unit based on the entered information into system 10. The information displayed by user interface 270 is used to review the capital cost of a potential investment and for calculating the annual maintenance costs. For a specific power Gross Output, the system computes a Total Cost of The Power Facility including Development Costs, Mine Acquisition Costs, Fixtures Costs, Land

& Building Costs, Management Services Cost, Infrastructure Costs, and Financing Fees & Costs.

[0057] Figure 19 is an exemplary embodiment of a user interface 300 displaying annual summary of maintenance expenses of all units at a given time for a selected facility. User interface 300 provides snap-shot details for each major category of expenses as well as average expenses for a given category over the last ten years.

[0058] Figure 20 is an exemplary embodiment of a Fees and Services Report 310 displaying Operator's Fees and Services. Report 310 identifies in detail General Project Information, as well as Operator Fee, Legal Services Cost, Construction Services Fees, and Testing Services Fees. Report 310 further identifies Travel Expenses and Miscellaneous Employee Expenses.

[0059] Figure 21 is an exemplary embodiment of a Direct Material Cost Summary Report 320 displaying direct material related information. Report 310 identifies in detail General Project Information, as well as Consumables Cost, Chemicals Cost, Gases Cost, Office Supplies and Services Cost, and the cost associated with Office Furniture and Renting.

[0060] Figure 22 is an exemplary embodiment of an Equipment Rentals/ Lease and Spares Report 340 displaying the cost associated with Rentals, Lease and Planned Spares information. Report 340 identifies in detail the cost associated with Tools, Equipment, Office Equipment, Rail Car, Trucks and other related expenses. Planned Spare Parts portion of the report focuses on Boiler, Turbine, APC Equipment, Feed Water System as well as BOP.

[0061] Figure 23 and 24 are an exemplary embodiment of a Fuel Report providing fuel characteristics to verify that appropriate equipment has been installed. Fuel Report displays Proximate Analysis, Project Coal Classification, Ash Mineral Analysis, PARR Formula Relationship and Natural Gas Analysis.

[0062] Figure 25 is an exemplary embodiment of a Coal Offsets Report. The report calculates the cost of sulfur dioxide offsets that the unit will need for a given coal. In an exemplary embodiment, the cost from this report is linked to Operational Cost Summary Report.

[0063] Figures 26 and 27 are an exemplary embodiment of an O & M Labor, Purchased Power and Fuel Calculations Report. The report estimates the labor force and associated cost required to operate a facility based on the number of units inputted. In an exemplary embodiment, cots included in database 20 associated with this report are linked to published CPI data using the zip code of the facility.

[0064] Figures 28 and 29 are an exemplary embodiment of a Turbine Generation Report. The report calculates a steam correction factor based on load, which is used in performance worksheets (report). The report provides Exhaust Pressure, Heat Rates at varying loads, and a steam correction factor.

[0065] Figure 30 is an exemplary embodiment of a Dispatch Information Report. For a given average annual capacity, the report computes a capacity factor, an availability factor, an average load, hours in year, hours dispatched, and an annual output. The report further provides hours available for dispatch and total hours dispatched. The report further computes an average annual load for a given plant.

[0066] Figure 31 is an exemplary embodiment of an Operations Report providing an annual summary of key information used in analyzing a potential investment. Although the report provides information for year 2001 through year 2005, the analysis can be extended for 25 or 50 years, as desired. The report provides Dispatch Information and Heat Rate Information. For a given heat rate, the report further breaks down the data into Fuel Fired, Total Ash, Total Limestone, Total Flyash, Gross Generation, Gross Heat Rate, Net Generation, Plant Net Heat Rate, and Dispatch Information Report.

[0067] Figure 32 is an exemplary embodiment of a Carbon Tax Costs Report. The report provides the potential carbon tax costs based on assumed carbon tax rate. The results of the report are linked to the Operations Cost Summary Report.

[0068] System 10 provides flexibility to estimates the annual maintenance cost of a unit based on an assumed major maintenance schedule (not shown). System 10 further provides a summary of unit costs generated in the Capital Cost worksheet, a fifty-year maintenance cost breakdown and the actual predicted maintenance expense based on the number of hours that the unit has been operated. Lookup functions are used to link various tables together (not shown).

[0069] Figure 33 is a flow chart 500 for a Power Plant Revenue Prediction System (PPRPS) (shown in Figure 1). Initially, the user accesses 510 a home page (not shown) of the web site through client system 14 (shown in Figure 1). The home page displays several options 550 including updating the database, searching the database, or printing one of the reports identified in Figures 11 through 32. Once the user selects 552 a specific option from the various hypertext links, the request is transmitted 560 to server system 12. Selecting 552 the option is accomplished either by the click of a mouse or by a voice command. Once server system 12 (shown in Figure 1) receives 562 the request, server system 12 accesses 570 database server 16 and retrieves 572 the requested information from database 20 (shown in Figure 1). The requested information is downloaded 580 and provided 582 to client system 14 from server 12. The user continues to search database 20 for other information or exits 600 from PPRPS 10.

The user updates 602 the contents of the database by adding, deleting or editing the contents of database 20 through a displayed user interface. After updating 602 the contents, the user selects an option to update the database 604. The user may continue the process or exit from the system.

In another embodiment, the home page displays several options identified above and also displays the options for retrieving various management reports. If the user wishes to obtain management reports, the user may obtain the reports by selecting 612 a specific hypertext link. Once the user selects 612 a hypertext link, the user then inputs 616 Criteria/Parameters of the report and transmits 560 a request to the server system by selecting a submit button (not shown). Transmitting 560 the request directs server system 12 to retrieve 572 the data from centralized database 20 and provides 582 the data to the user on the user's interface in a pre-determined format.

[0070] In one other embodiment, client system 14, as well as server system 12, are protected from access by unauthorized individuals. As described, PPRPS 10 includes interactive searchable database 20 for storing Boiler Data, Feed Water Data, Balance of Plant Data, Turbine Data, and APC Equipment Data. Database 20 provides flexibility to employees as well as management to maintain business information up-to-date.

[0071] While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.